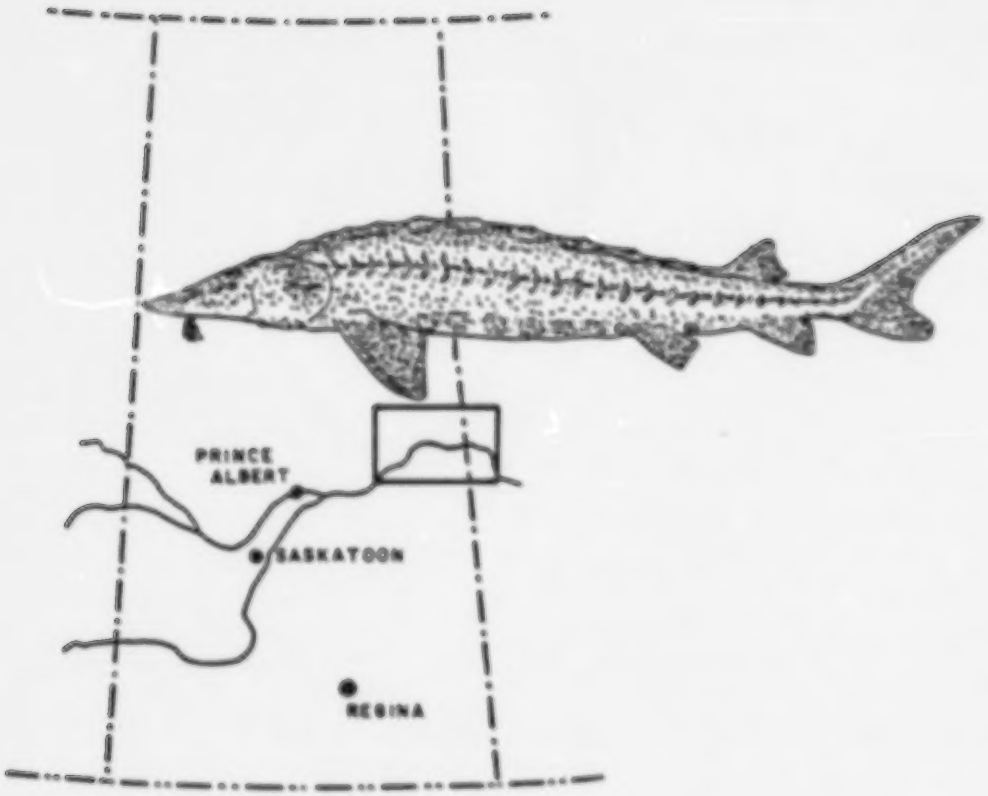
Species Recovery Plan for Lake Sturgeon in the Lower Saskatchewan River (Cumberland Lake area)

Technical Report 91-3



SPECIES RECOVERY PLAN

FOR

LAKE STURGEON

IN THE LOWER SASKATCHEWAN RIVER

(CUMBERLAND LAKE AREA)

by

ROBERT G. WALLACE

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EXECUTIVE SUMMARY

STATUS

The lake sturgeon population in the lower Saskatchewan River and Cumberland Lake area was affected by habitat changes and loss of spawners about 1960. The population cannot sustain itself under present habitat conditions and fishing harvests.

Prior to 1960 the size and age composition of the population was healthy. Available habitat was suitable for young, mature, and spawning sturgeon, and fishing had been sustained since the early 1900's.

About 1960, the reproductive potential of the population was reduced considerably by the loss of many mature sturgeon and the loss of water flow in the spawning areas. Since the late 1960's, hydro-electric operations have reduced the suitability of the remaining habitat. Commercial (and sport) fishing are not sustainable at former levels, but have continued relatively unchanged.

This population will decline to a remnant population or become extinct locally if mitigation of habitat degradation and changes in fishing are not undertaken. Its collapse may become an issue for the users of Cumberland House community, who have used legal means to address grievances in the past, and should be a concern to those responsible for resource management.

Historically, this species has been depleted by overfishing and habitat degradation in many provinces and states. Recognized agencies have assessed lake sturgeon, at various times, as endangered (CITES - Convention on International Trade in Endangered Species), or threatened by habitat degradation (AFS - American Fisheries Society), or jeopardized if management and habitat protection are not undertaken (COSEWIC - Committee on the Status of Endangered Wildlife in Canada). Special management or recovery plans are underway in several provinces and states (e.g. Alberta, Manitoba, Missouri, Wisconsin, Minnesota, New York).

BACKGROUND

The lake sturgeon is the only North American sturgeon species to regularly inhabit freshwater. Saskatchewan has resident populations in the Saskatchewan River system, and in the lower Churchill River near Island Falls.

Lake sturgeon are primarily residents of large rivers and lakes, and depend on suitable habitat conditions in spring and early summer for successful spawning. Sturgeon spawn in or below rapids, the eggs incubate among rocks or gravel about one week, and the fry hide beneath rocks until they move into quiet backwater habitats. Lake sturgeon grow slowly and reach maturity late, and each female spawns only about once every five years.

Monitoring of the population in the lower

Saskatchewan River occurred in 1958-63, 1966, 1975-82, and 1990 with the co-operation of the commercial fishermen. Assessment of sizes and ages, proportions of mature fish, and mortality rates indicated serious problems had arisen by the early 1960's.

The history behind the present situation can be summarized as follows:

1) the loss of half of the mature sturgeon population about 1960, during development of the Squaw Rapids (now E.B. Campbell) hydro-electric station, reduced the available numbers of eggs and potential reproduction;

2) the re-routing of natural waterflows around the Tobin and Squaw rapids about 1962 eliminated these large spawning areas on the lower Saskatchewan River;

3) hydro-electric operations have further reduced the suitability of remaining habitat during spawning seasons, by reducing average waterflows and creating very low waterflows overnight;

4) commercial (and sport) fishing have continued at former levels, even though the loss of spawners and the loss of habitat have reduced the productivity of the population.

The long-term effects of reduced reproduction were confirmed by monitoring the commercial fishery in 1990. Only 8 to 15% of the former number of young sturgeon are being reproduced by the relatively few remaining spawners under the present habitat conditions. The long period before young

sturgeon are catchable (about age 19) delayed the appearance of any symptoms in the fishery until the early-1980's or later.

ISSUES

Management options should address the following issues:

(1) Habitat impacts have affected reproduction seriously since 1960 due to loss of spawning areas, loss of mature sturgeon, and reduced waterflows.

(2) Commercial and sport harvests were formerly sustainable, but will result in the loss of the remaining mature sturgeon under the present quota and minimum-size regulations.

RECOVERY PLAN

Fisheries Branch should consult with users and other agencies and implement this Species Recovery Plan with their co-operation. This will mitigate earlier impacts and restore lake sturgeon to a self-sustaining status closer to their former abundance.

Information: Fisheries Branch would advise relevant agencies (e.g. Saskatchewan Power Corporation (SPC) and Manitoba) and fishermen of the status of the population, provide available information for their assessment and study if requested, and advise on the biological issues in suggested management options.

Habitat: Fisheries Branch would request SPC to

assess alternatives and to mitigate historical and ongoing habitat impacts (e.g. by restoring former spawning areas or creating new areas). In particular, Fisheries Branch would request SPC to maintain a suitable water flow regime in existing or new habitat areas during the annual spawning and nursery period. Fisheries Branch could advise SPC or assist in co-operative studies if suitable.

Fishing: Fisheries Branch would discuss management options (e.g. reduced quotas and protection of spawners and critical areas), and would implement changes which will improve the long-term outlook for this population.

Enhancement: Fisheries Branch would assess any requests for restocking lake sturgeon from a local or other hatchery, for mapping of critical habitat areas, or for other site-specific proposals.

Interprovincial: Fisheries Branch would discuss this plan with Manitoba counterparts since the population may migrate between Saskatchewan and Manitoba. Fisheries Branch would request co-operation in their management of commercial, sport, and food fisheries, in any biological monitoring, and in any restocking or other enhancement program.

Funding: Fisheries Branch would apply for funding from suitable federal or provincial programs (e.g. RENEW Recovery of Nationally Endangered Wildlife, and ESRF Endangered Species Recovery Fund) to restore habitat and protect reproduction and to monitor progress.

ACKNOWLEDGEMENTS

This study would not have been possible without the assistance and advice which I received from many people. I thank all those who participated over the years of the study.

Conservation Officers D. McKay, D. Jessop, R. Brunt, L. Sullivan, K. Buettner, and G. Hood and staff participated in fieldwork and collected other data. The commercial fishermen of Cumberland House co-operated with and assisted District and Fisheries staff, at some inconvenience. They also shared their understanding of lake sturgeon, the history of the area, and its fisheries, and their concerns for the resource.

Library staff (especially L. Kozun, P. Somerton, B. Blyth, and A. Battiste) patiently researched the literature on sturgeons and obtained specific references. V. Ohly and L. Heinze at Environment Canada provided hydrological data and advised me on their interpretation.

L. Royer and M. Atton discussed their previous surveys in the Cumberland Lake area, and the latter reviewed the ageing of some recent specimens to improve comparability. W. Musker and C. Brinkhurst worked diligently to refine the preparation and ageing of finrays.

B. Wright and A. Derksen of Manitoba and D. Radford and F. Bishop of Alberta provided available data from provincial studies and their fisheries. G. Priegel and T. Thuemler of Wisconsin, R. Fortin of Quebec, and N. Auer of

Michigan described experiences with habitat issues and restoration in their respective areas.

I appreciate my earlier discussions with A. McCutcheon, D. Walton, and L. McFarlane, and the review of this report by W. Sawchyn and M. Chen. Their comments, questions, and requests for clarification on some topics have improved my understanding and its presentation. C. Schurr re-typed and formatted this report and V. Wolkosky drafted some of the figures most capably.

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1. INTRODUCTION

The lake sturgeon (*Acipenser fulvescens*) is found in fresh water in east-central North America (Fig. 1). Primarily a resident of large lakes and large rivers, the western limit of its range is the Saskatchewan River in Saskatchewan and eastern Alberta (Scott and Crossman 1973, Magnin 1966, Haugen 1969). The history of lake sturgeon management in many areas has been one of large harvests, rapid declines in harvests or sizes, and a lack of studies of population status and habitat conditions to maintain or restore self-reproducing populations. In some cases, harvests of hundreds of thousands of sturgeon annually have fallen to mere hundreds within 20 to 30 years, while habitat degradation went unnoticed or uncontrolled (Harkness and Dymond 1961, Priegel 1973, Mosindy 1987).

Lake sturgeon grow slowly, reach maturity late, and spawn infrequently compared to other species (Scott and Crossman 1973, Roussow 1957, Sunde 1961, Royer et al. 1968). Their productivity and sustainable harvests are accordingly low (Harkness and Dymond 1961, Baker 1982, OMNR 1987).

Lake sturgeon spawn in late May to mid June among rocks in rapids, or at the foot of impeding falls. Eggs are adhesive and incubate among rocks or gravel about one week. Fry hide beneath rocks for one to two weeks until they move into quiet backwater habitats and feed freely (Harkness and Dymond 1961). Successful reproduction is therefore dependent

Figure 1. Range of the lake sturgeon of North America (adapted from Harkness and Dymond 1961).

on river conditions during and following spawning (Lauer 1988, Votinov and Kasyanov 1978).

The objectives of this report are (1) to assess the biological status of the population since 1958 (using age and size compositions, mortality rates, reproductive potential, and yield models), (2) to assess habitat conditions downstream of the former Squaw Rapids (e.g. magnitude and timing of waterflows, and spawning areas), (3) to outline the status of the population in 1990, and (4) to recommend options for fisheries management and habitat restoration to allow this population to recover to its former status. The area of study is the Saskatchewan River and Cumberland Lake, bounded by Squaw Rapids, Grand Rapids (Manitoba), and Namew Lake, and includes rivers and channels such as the Torch, Mossy, and Old Saskatchewan rivers (Fig. 2).

2. FISHING

Lake sturgeon have been commercially fished since about 1900 in the Cumberland Lake area, including Namew Lake and as far as the Torch River. Harvests in the early years were highly erratic as a result of fluctuating prices, uncertain transportation links, and variable demand from buyers (Judson 1961). Since 1940, harvests have been relatively stable under management quotas of 2,700 to 3,600 kg (dressed weight of fish with heads, viscera, and fins removed); the present quota is 3,200 kg (Fig. 3).

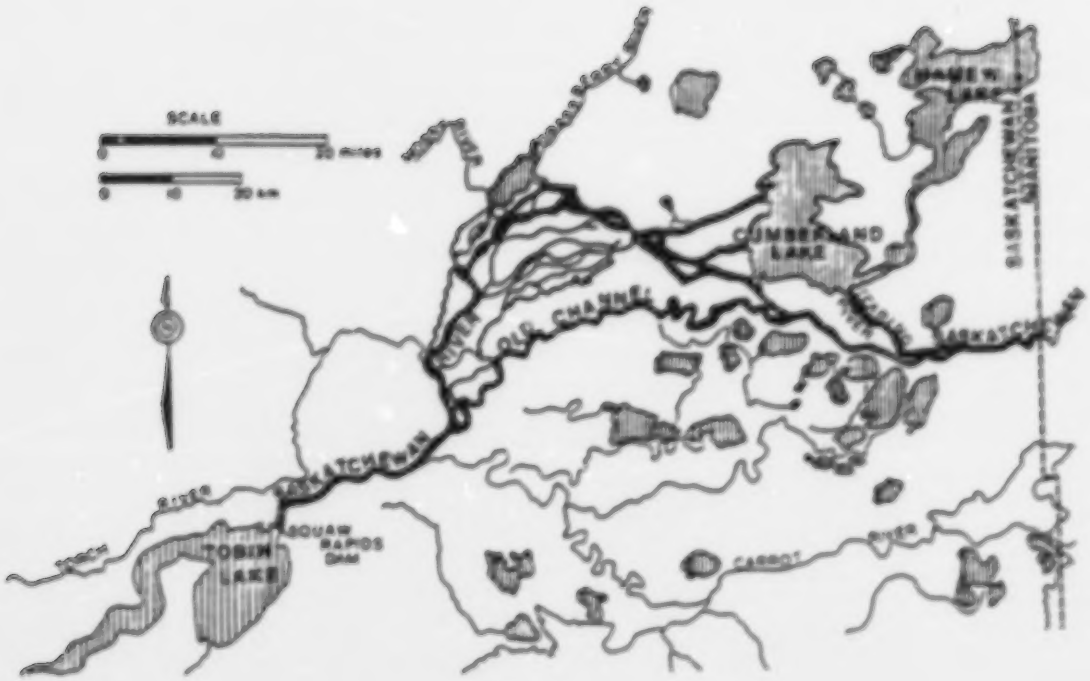


Figure 2. Lower Saskatchewan River and channels in the Cumberland Lake area.

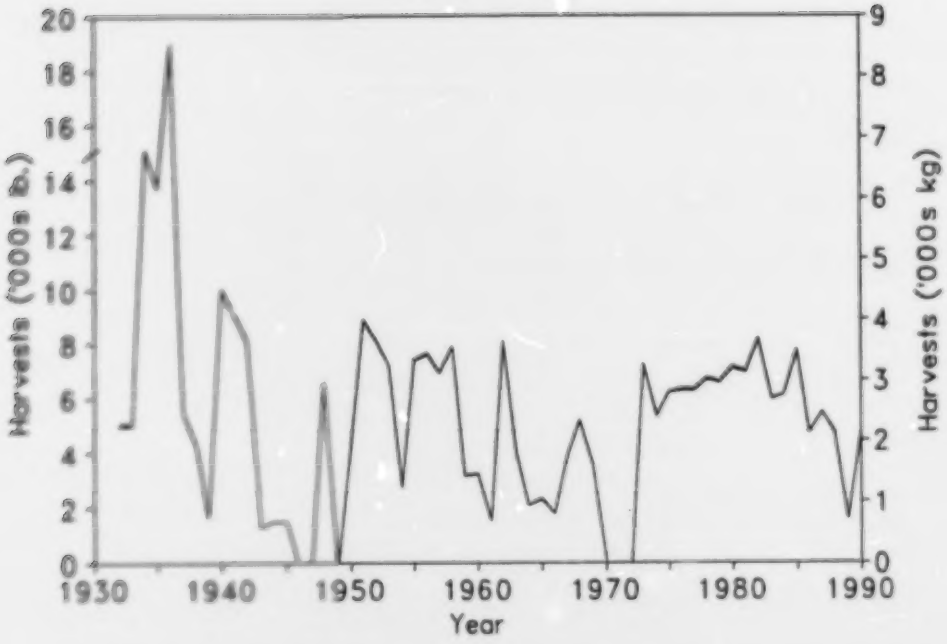


Figure 3. Commercial harvests of sturgeon in the Cumberland Lake area, 1932 to 1990.

Since 1940, gillnets of 10 to 12-inch mesh (presently 12) and baited hooklines have been used in the river and in the lake. Hooklines were observed in 1941 (M. Chappuis, January 1942, Fisheries Branch files) and produced "over one-half of the sturgeon caught" in 1956 (A.H. MacDonald, February 1957, Fisheries Branch files). Closure of the fishery was recommended in the 1940's and 1960's due to low harvests and poor marketing facilities, and in 1970-1972 due to concerns about mercury (Fisheries Branch files, Reed 1959, Royer 1966, The Saskatchewan Gazette 1941-1984).

A yield-per-recruit model based on the situation in 1958 shows that the quota of 3,200 kg was sustainable for a population of 10,000 fishable sturgeon. The simple model of Ricker (1975 p.237) estimates that 3,600 to 5,760 kg were sustainable, assuming that fishing caused 50 to 80% of the total mortality. The abundance of fishable sturgeon was estimated at 5,000 to 16,000 using two different methods (see below).

Sturgeon remain one of the most valuable commercial species, with prices of $ 7/kg at the lake. Fishing is an important seasonal activity in this area since alternatives are limited. Recently, about 30 fishermen and 10 helpers have been active, with each crew fishing traditional sites by mutual agreement.

Recent sport harvests in the Saskatchewan River below Squaw Rapids are believed to be relatively low. Sport

fishermen harvested about 500 lake sturgeon annually across the province from 1975 to 1985 (A.R. Murray pers. comm.; Murray and Brickley 1988). Known sport fishing areas for this population include access points at Squaw Rapids and nearby downstream.

3. BIOLOGICAL STATUS

Monitoring of the commercial fishery at Cumberland House provides most of the information on this population. Data collected in 1958-1963, in 1966, and in 1975-1982 showed significant changes in this population over this period (Royer 1966, Wallace 1983).

3.1 AGES, MORTALITY, GROWTH, AND SIZES

Age compositions were the first indicator of serious changes in the population between 1958 and 1975-1980 (Fig. 4). Most importantly, sturgeon in their 40's, 50's, and 60's completely disappeared. Furthermore, the peak age of sturgeon in the commercial fishery declined from 22 to 19 years.

Age compositions were derived from data on dressed weights and separate age-weight keys for 1954-1966 and 1975-1980, and from direct ageing of sturgeon harvested in 1990. Ages were obtained from pectoral finrays collected by Royer et al. (1968) in 1958-1966, by SPRR staff in 1975-1980 (Walton 1976, Wallace 1983), and by commercial fishermen in 1990, and read by conventional methods (Cuerrier 1951, Sunde 1961, and Wilson 1987).

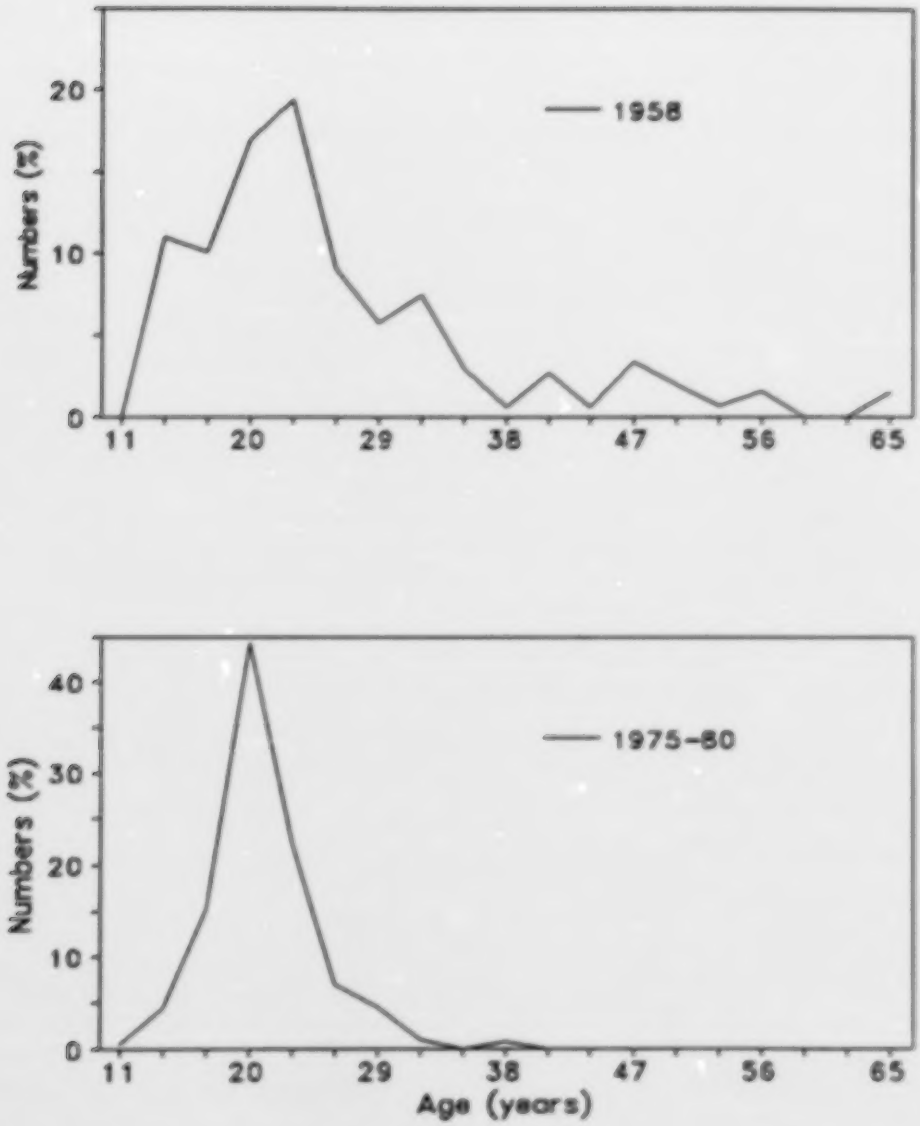


Figure 4. Age compositions (3-year groups) of sturgeon in commercial harvests in 1958 and 1975-80.

Ageing appeared to be comparable between other age-readers and the principal reader (W.A. Musker), and as precise as expected for sturgeon. Earlier workers re-aged fins collected in 1975-1977 "about one or two years older" than recent workers (F.M. Atton, October 1975, Fisheries Branch files). Materials from 1977-1982 and 1990 were aged comparably by readers (W.A. Musker, C.L. Brinkhurst, and R.G. Wallace).

The annual mortality rate rose from 4.8% in 1958-1963 to 18.9% in 1975-1980. This was an unacceptable rate for a species with infrequent spawning and low recruitment rates (i.e. low numbers of sturgeon being reproduced and growing into the fishable-sized segment of the population). Natural recruitment was about 3.5% in 1958 in this population. Recommended maximum mortality rates are 5%, based on observed recruitment of 4.7 to 5.4% in other self-sustaining populations (Priegel 1973, Priegel and Wirth 1975, Baker 1982, Sunde 1961).

Growth of these sturgeon was moderate compared to other populations, as expected for the geographic location and climatic conditions (Fig. 5; Royer et al. 1968). Growth is faster in more southerly areas in Wisconsin and the St. Lawrence River, and slower in northern areas in Manitoba, Ontario, and Quebec (Priegel 1973, Priegel and Wirth 1975, Priegel and Wirth 1978, Harkness and Dymond 1961, Sunde 1961, Magnin 1977). Conversions and relationships between length, weight, and age which may be useful in management options are shown in Table 1.

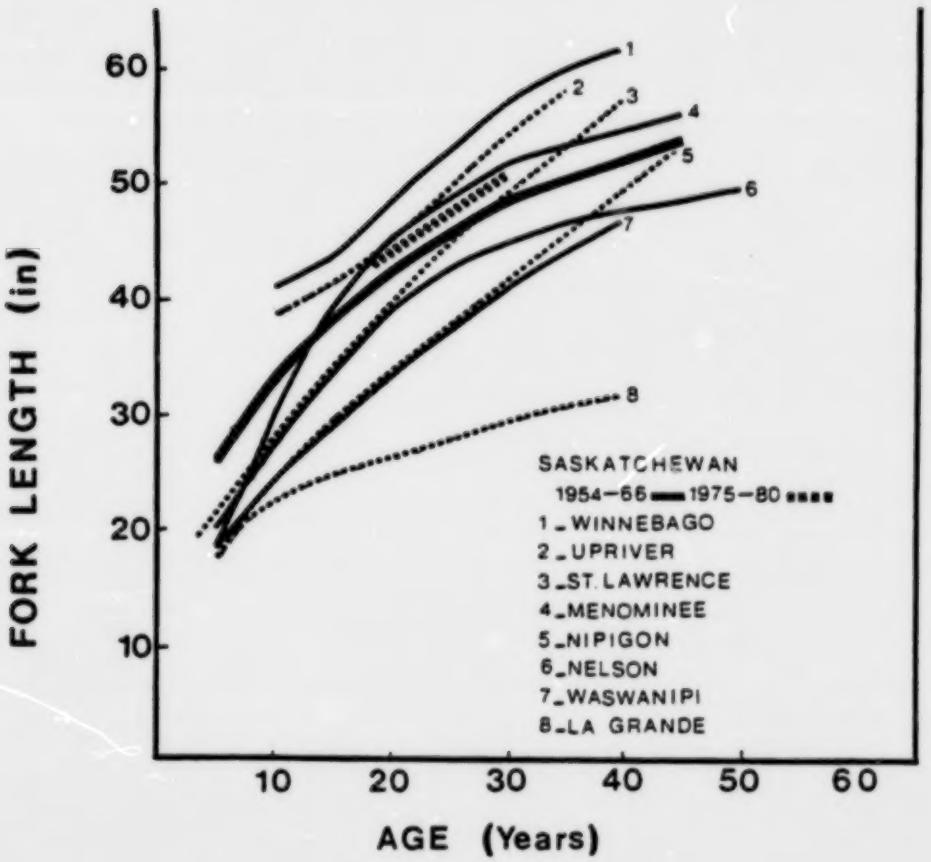


Figure 5. Growth of lake sturgeon in the lower Saskatchewan River and eight other populations (see text).

Table 1. Relationships between size, age, and form of sturgeon in the lower Saskatchewan River.

Dressed weight (lb.) = 1.374 + 0.594 Age (years) Age (years) = -2.313 + 1.684 Dressed weight (lb.) (1954-1966 survey and commercial data, n=98, r2=0.66)
Log dressed weight (lb.) = -0.174 + 0.985 Log age (years) (1954-1966 data, n=98, r2=0.73)
Fork length (inch) = 58.54[1 - exp{-0.0503(Age - 5.553)}] (1954-1966 von Bertalanffy curve, n=37 means, range 12-64 inch)
Log round weight (lb.) = -4.027 + 3.264 Log fork length (inch) (Royer et al. 1968, n=21 means, range 15-70 inch)
Fork length (inch) = 31.106 + 0.634 Age (years) (1975-1980 commercial data, n=189, r2=0.40)
Log round weight (lb.) = -3.377 + 2.881 Log fork length (inch) (1975-1980 data, n=18 means, range 37-57 inch)
Log dressed weight (lb.)= -3.763 + 2.998 Log fork length (inch) (1975-1980 data, n=71, range 37-55 inch, r2=0.82)
Log round weight (kg) = -5.585 + 3.22169 Log fork length (cm) (1984 data, n=344, range 35-130 cm, r2=0.97)
Ratio of dressed weight to round weight = 0.58 at 2.4 lb. and 0.66 at 50.6 lb. round weight

Females were 90% mature at a fork length of 50 inches (127 cm), round weight of 30 pounds (13.6 kg) or dressed weight about 20 pounds (9.07 kg), and age of 25 years (Fig. 6). (The term "mature" includes females with visible eggs of any size, many of which will take several years to spawn.) Length and weight appeared to be more reliable indicators of maturity than age, although only about 125 sturgeon were examined for maturity. Females spawn once every 4 to 8 years in this population, judging from the proportion of mature-sized females observed to have ripe eggs. The size and age at maturity are comparable to other populations, as is the frequency of female spawning (every 4 to 6 years in other populations) (Magnin 1966). Males mature smaller and younger than females, and appear to spawn every 2 years in Saskatchewan, again similar to other populations.

3.2 LOSS OF LARGE STURGEON

The size composition of commercial harvests showed a loss of larger sturgeon from 1958 to 1963, similar to the loss of older sturgeon. Since sizes were available for 200 to 600 commercially harvested sturgeon annually, and show better resolution from year to year than ages do, these trends were assessed further (Fig. 7).

The trend in the proportion of large sturgeon showed clearly a notable depletion of this segment of the population.

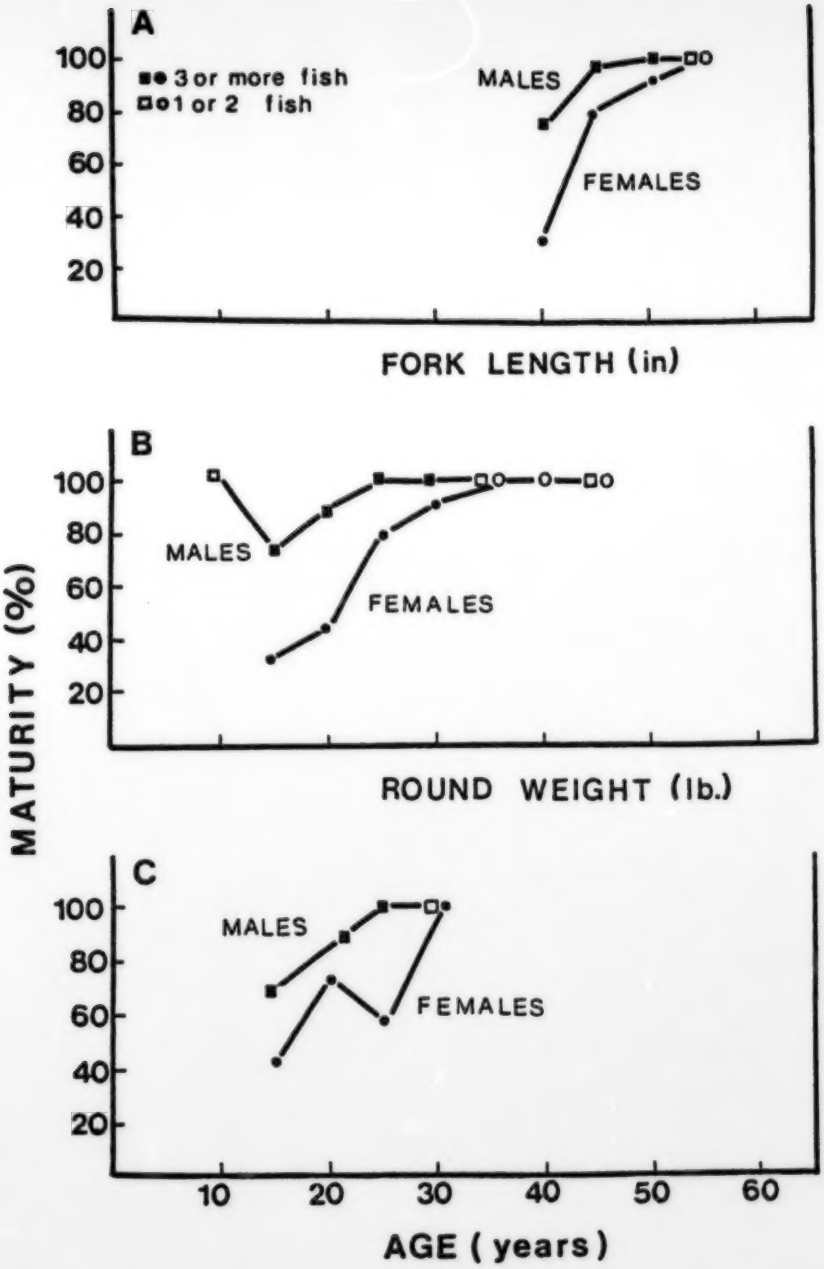


Figure 6. Size and age of maturity of male and female sturgeon.

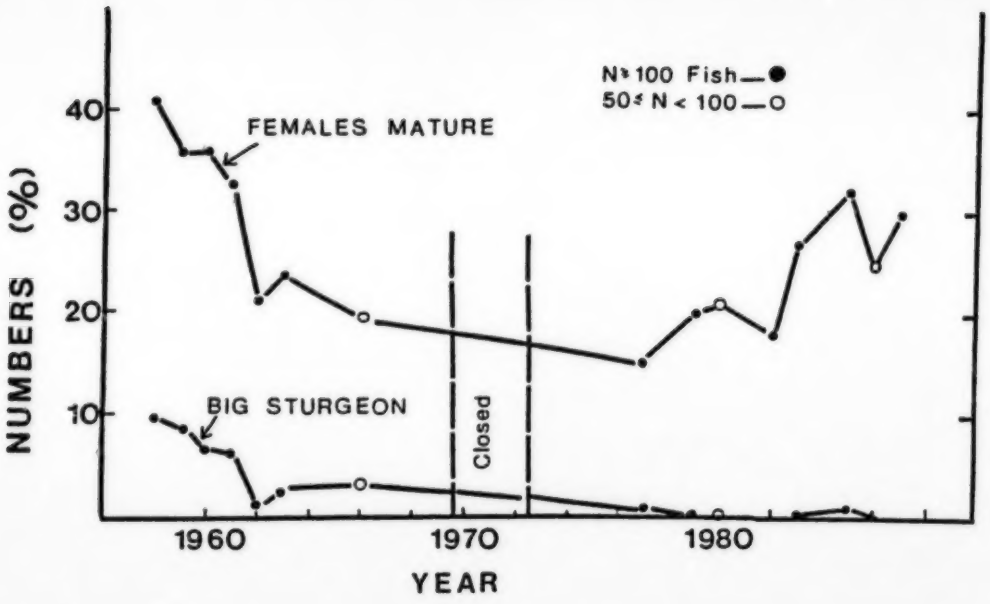


Figure 7. Proportions of larger sturgeon in commercial harvests, 1958 to 1980.

Sturgeon which were large enough to be mature females (i.e. over 20 pounds or 9 kg dressed weight) declined in abundance from 41 to only 22% in harvests between 1958 and 1963. A similar decline occurred in other categories of large sturgeon (e.g. "big" sturgeon over 35 pounds or 16 kg) at this time. These trends may over-estimate the actual proportion of mature sturgeon in the population, but show the magnitude and timing of the change. The indices are comparable from year to year as they are based only on fish weighing more than 12 pounds or 5.4 kg dressed weight. This avoids complications due to the variation over several decades of the minimum marketable size of sturgeon (e.g. typically 10 to 12 pounds, dressed weight).

This loss of large sturgeon implies a substantial loss of reproductive potential, especially since larger females possess more eggs than medium-sized ones and since females outnumber males at larger sizes. The importance of the loss lies primarily in the lower absolute abundance of large sturgeon, rather than in the relative numbers of different-sized sturgeon. Basically, every 1,000 large sturgeon in the 1958 population were reduced to only 540 survivors in 1963 and later years.

The possible causes for this depletion from 1958 to 1963, and assessments of their likelihood follow.

1. Larger sturgeon probably were lost or removed by accidental stranding, by blockage of migrations, or by habitat disturbances (e.g. siltation). The timing of the decline and

the proximity of the major spawning areas suggest that increased activity at the Squaw Rapids station was directly or indirectly responsible. Surveying and construction began prior to 1960, the reservoir was filled in the autumn of 1962, and power generation began in 1963 (Royer 1969, Durbin 1981, Department of Natural Resources Annual Reports 1961-62 and 1962-63).

Stranding of sturgeon has been observed in similar cases (Harkness and Dymond 1961 p.74, Lauer 1988) and has been reported by residents of Cumberland House and others (J.V. Carriere, June 1984, pers. comm.), so it is considered to be likely. Blockage of downstream migrations and the resulting loss of large sturgeon to upstream areas is possible, but requires that closure of the dam occurred at the proper time and may be less likely. Increased siltation is unlikely to have caused greater mortality of large sturgeon than of eggs, fry, and young sturgeon since the latter are generally more sensitive and less mobile.

2. Unknown persons legally fishing for sport, domestic, or commercial use likely increased their harvests about 1960 due to improved access or other factors. If sturgeon were trapped or stranded in pools, especially larger ones during the spawning period, their capture would have been relatively easy. There is anecdotal evidence of this (G.R. Bowerman, November 1962, Fisheries Branch files), and some increase in harvests of large sturgeon near Squaw Rapids is

considered to be likely.

3. Commercial fishermen may not have reported some commercial harvests about 1960. This is unlikely to be the only explanation of changes for several reasons. The unreported sturgeon had to be larger individuals in order to have caused the observed depletion. These sturgeon could have been sold legally, unless they were caught after the quotas were taken each year. However, the most likely source of relatively large sturgeon would occur prior to and during spawning, which is the traditional fishing period.

4. Commercial harvests in earlier years may have over-fished the spawning segment, causing reduced reproduction and lower abundance of larger sturgeon about 30 years later. Reported harvests peaked at 15,500 kg in 1928 and 8,500 kg in 1936 (Judson 1961, Royer 1966), which may have reduced reproduction of these year-classes.

This explanation is possible but unlikely, although it is difficult to assess with the data available for the 1920's. The observed decline after 1958 was more rapid than might be expected from a sustained over-harvest, and any sign of recovery from a brief over-harvest was lacking. The decline involved sturgeon aged 32 years or older, from the 1926 and earlier year-classes, so that the timing appeared to be incorrect. Commercial gear used prior to 1940 was less selective towards larger sturgeon than later equipment. Any presumed over-harvests were more likely general, rather than

specific to the larger, mature segment.

5. Changes in commercial fishing patterns may have occurred between 1958 and 1963 (e.g. movement into new areas), so that these trends in size may not represent the population consistently. However, fishing in a new area would more likely have caused an increase in numbers of larger sturgeon, rather than a decrease. Other changes in fishing may have occurred, but none which would explain the loss of larger sturgeon from 1958 to 1963 are obvious.

These explanations do not imply that this hydro-electric project was in any way unauthorized or that SPC was liable in any way for impacts, according to the environmental protection legislation in place about 1960. Similarly, any removal of larger sturgeon was not necessarily unauthorized or in any way illegal given the resource management regulations of the time.

The number of sturgeon which were lost or removed between 1958 and 1963 may have been approximately 500 to 1000 large sturgeon, over and above the reported commercial harvests. This does not seem to be an unrealistically large loss over 4-5 years. This estimate was based on a modification to the change-in-ratio technique for population abundance (Paulik and Robson 1969, Seber 1973). This modification estimates the unknown removals, using the initial population abundance, the change in proportion of one class of a population (e.g. sturgeon over 9 kg), and the known commercial

removals by size (Table 2). This approach assumes: (1) that commercial harvests represented the size composition of the population similarly from year-to-year, though not necessarily without bias, (2) that the two classes had equal recruitment, growth, and mortality rates, so that these effects were negligible (Seber 1973), (3) that commercial fishing gear was 3 to 5-fold selective towards larger sturgeon (Dadswell 1979, Wallace 1983), and (4) that the combined availability of larger sturgeon and preference of fishermen for larger sturgeon was 3-fold greater than for medium-sized sturgeon (Seber 1973). The presumed selectivity of fishing gear and greater availability of larger sturgeon (due to spawning behaviour) imply that the observed proportions of 41 and 22% large sturgeon in harvests actually over-estimate their presence in the population, as noted above.

3.3 POPULATION ABUNDANCE

There were two estimates of abundance in 1958: one of 10,000 to 16,000 sturgeon, and the other about 5,000 sturgeon.

Commercial harvests of about 400 sturgeon annually and an exploitation rate of 0.025 to 0.039 indicated a fishable population of 10,000 to 16,000 sturgeon about 1960. The numbers of sturgeon harvested annually were estimated from reported harvest weights and the average weight of sturgeon; the exploitation rate was derived from the mortality rate of 5% in 1958-1963 (Ricker 1975).

Table 2. Number of sturgeon in commercial harvests, by dressed weight interval, 1958 to 1990.

Year	1958	1959	1960	1961	1962	1963	1966	1977	1979	1980
Weight(lb.)										
5-7	28	89	1	1	0	0	0	0	0	0
8-10	172	111	21	60	10	6	0	34	0	0
11-13	123	97	29	84	113	50	15	86	77	16
14-16	106	83	21	31	123	45	23	34	105	32
17-19	80	43	5	27	82	37	12	19	70	16
20-22	51	34	9	18	36	19	4	7	30	4
23-25	34	18	3	6	18	8	4	5	26	6
26-28	18	10	4	8	15	4	1	2	2	3
29-31	20	8	2	0	7	2	1	4	4	1
32-34	8	4	1	2	3	2	0	1	1	3
35-37	7	4	0	0	2	0	1	0	0	0
38-40	10	6	0	0	0	2	0	0	0	0
41-43	5	1	3	2	0	1	0	0	0	0
44-46	3	3	0	2	0	0	0	0	0	0
47-49	2	1	0	0	0	1	0	1	0	0
50-59	6	3	0	3	2	0	1	0	0	0
60-69	3	1	0	1	0	0	0	0	0	0
70+	2	4	1	0	0	0	0	0	0	0
n=	678	520	100	245	411	177	62	193	315	81

Year	1982	1983	1985	1986	1987	1988	1989	1990
Weight(kg)								
4.0-4.4	1	3	0	0	3	1	1	14
4.5-4.9	4	0	0	3	11	6	4	13
5.0-5.4	20	2	29	13	25	13	7	34
5.5-5.9	22	8	20	15	28	18	9	31
6.0-6.4	31	46	79	32	28	29	11	35
6.5-6.9	27	26	19	22	14	22	9	21
7.0-7.4	14	30	55	38	18	23	5	26
7.5-7.9	12	27	20	18	15	17	6	21
8.0-8.4	18	25	54	19	26	28	11	16
8.5-8.9	7	20	13	10	14	11	12	14
9.0-9.4	10	13	40	16	11	17	6	15
9.5-9.9	5	12	9	7	9	11	4	10
10-10.9	4	19	21	20	12	27	2	11
11-11.9	2	6	18	14	15	8	4	12
12-12.9	5	6	5	9	7	6	2	3
13-13.9	2	2	9	4	5	3	1	2
14-14.9	0	2	1	3	1	3	0	2
15-15.9	0	6	1	0	1	3	0	4
16-16.9	0	1	1	1	0	0	0	1
17+	0	0	1	0	0	1	0	2
n=	184	254	395	244	243	247	94	287

Prior to 1982, numbers of fish were reported in 3-pound intervals. Since 1982, dressed weights (rounded to 0.1 or 0.5 kg) have been recorded for individual sturgeon.

Total mortality was considered to be 50 to 80% due to fishing and the remainder due to natural causes. The fishery was considered to be in equilibrium about 1958, judging by the longterm harvests and the stable age and size compositions of the population (see above).

Available habitat may support 5,000 sturgeon (range of 2,000 to 13,000) in the lower Saskatchewan River between Squaw Rapids and Grand Rapids (Manitoba). Studies have found an "average" of 5.5 medium and large lake sturgeon per km of river in other exploited populations. Observed densities range from 2 to 14/km for sturgeon over 36-42 inch length or 11-15 pounds dressed weight (Priegel 1973, Priegel and Wirth 1975, Radford 1980 corrected for mortality of tagged sturgeon, Sopuck 1987 corrected similarly). Some of these populations are known to be over-exploited and/or suffer from habitat degradation.

4. HABITAT

4.1 GENERAL

The habitat of this sturgeon population presently consists of 900 km of river channels. This includes the Old Saskatchewan River channel (130 km), Saskatchewan River (265 km), Tearing River (15 km), and major channels in the delta area (490 km), but excludes Namew Lake and upstream (maps of 1:250000 scale; see Fig. 2). The shallow, warm water is

relatively fertile and "good" sturgeon habitat according to their requirements. This is also a relatively large area compared to that of some populations, even though it is restricted by dams upstream and downstream.

It is unknown whether this population moves regularly between Saskatchewan and Manitoba. Migrations of sturgeon can cover long distances, ranging from spawning migrations of 80 km (Priegel and Wirth 1978) to individual movements of 125 km (Radford 1980) and more, so large-scale movements are feasible. Yet studies note that populations frequently overwinter nearby if deepwater areas are available (Harkness and Dymond 1961, Kempinger 1988). Two sub-populations of lake sturgeon migrate about 45 and 70 km between upriver summer and downriver winter habitat of the South Saskatchewan River in Alberta, more or less separately (Radford 1980). Localized movements within Saskatchewan may predominate if deeper pools in the river are suitable winter habitat.

Migrations of sturgeon can be complex. Groups which differ in size, age, and maturity tend to have different migration patterns for spawning, feeding, and overwintering (Tsyplakov 1978, Dadswell 1979). There may also be long-term bonding by individuals, since recaptures together occurred for migrating individuals which were marked together in earlier years (Dadswell 1979).

4.2 SPAWNING SITES

The former spawning sites at Tobin and Squaw rapids became dry and largely revegetated as a result of the power canal bypass, and very rare releases of water over the spillway and former rapids (R. Halliday, Environment Canada, pers. comm.). The earthfill dam creating Tobin Lake is located at the head of the former Tobin Rapids and the powerhouse and tailrace at the foot of the former Squaw Rapids. These were almost certainly major spawning sites on the Saskatchewan River according to documented requirements (Scott and Crossman 1973, Willard et al. 1978).

Other potential spawning sites have been identified on the basis of topographic gradients in nearby rivers (e.g. Torch, Mossy, and Missipuskiow rivers), fishing of sturgeon nearby or on access routes to these areas, and local reports (e.g. Bigstone Rapids pers. obs., Torch River cited in Willard et al. 1978). These sites are believed to be secondary to the use of the main river, but this cannot be determined from available information on habitat.

4.3 WATERFLOWS

The Saskatchewan River historically showed two natural peak flows. The first of these, in April or May, represented snowmelt on the prairies and was brief in duration. A more prolonged and higher peak in June and July was due to

arrival of the meltwater of mountainous, headwater areas (Royer 1969). As a result of the operation of the Squaw Rapids dam since 1963 and the upstream Gardiner dam since 1968, a number of changes have been noted.

Longterm natural waterflows in downstream areas in June were reduced considerably (Fig. 8). The operation of the Squaw Rapids dams caused a decrease of 20% after 1963. The Gardiner dam caused further reduction, for a total decrease of 55% after 1968. Monthly waterflows were derived from Environment Canada data on the North Saskatchewan River at Prince Albert and the South Saskatchewan River at Saskatoon (pre-1945), and the Saskatchewan River at Nipawin (1945 to 1962) and below Squaw Rapids (post-1962).

Changes in magnitude and timing of river flows below hydro-electric dams have affected the reproduction and early life stages of several sturgeon species. Effects range from the resorption of maturing eggs during abnormal winter discharge patterns (Altufyev et al. 1980) to reduced year-class abundance in altered spring waterflows below dams (Khoroshko 1972, Votinov and Kasyanov 1978). In Wisconsin, cessation of spawning by lake sturgeon resulted from very low waterlevels in May and June below hydro-electric stations (G.R. Priegel pers. comm.). The relationship between year-class abundance and water flow can be complex, involving threshold water level, water temperatures, and rising versus falling trends (Votinov and Kasyanov 1978, Veshchev and Novikova 1983). Detecting such

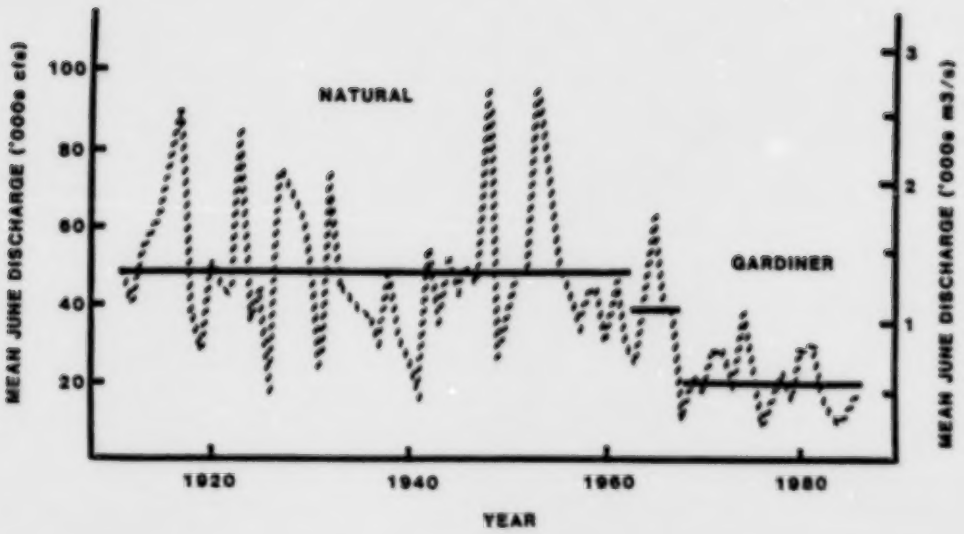


Figure 8. Average daily waterflows in June below Squaw Rapids, 1912 to 1986.

impacts usually requires sampling for eggs, fry, or young sturgeon with drift-nets or electrofishing (Priegel 1973, Votinov and Kasyanov 1978).

Hourly fluctuations in waterflows in May, June, and July are much more extreme than under natural conditions and expose large areas of riverbed, especially overnight. Under natural conditions, maximum exposure of the riverbed was 10% or less during the spawning and nursery period in June. Data from May 1980 showed that overnight low waterlevels exposed about 69% of the riverbed under regulated conditions (Fig. 9) (R.A. Halliday, May 1982, Fisheries Branch files).

Fluctuations in waterflows were observed to cause the stranding and death of fish (including small sturgeon) up to 18 km downstream in the mid-1970's (K.B. Hunt, July 1977, Fisheries Branch files; Durbin 1981). Fluctuations would also cause desiccation and death of incubating eggs, small fry under rocks, and perhaps free-swimming fry in backwater areas.

Hourly fluctuations occur periodically between May and August as peak electrical demands are met by the Squaw Rapids station, rather than higher-cost facilities (L. McLaren, Minister of SPC, November 1982, Fisheries Branch files). Other studies report that "weekend flows below Tobin Lake have been known to fall to zero" (Saskatchewan Environment 1980) and have recommended minimum instantaneous flows in SPC operations.

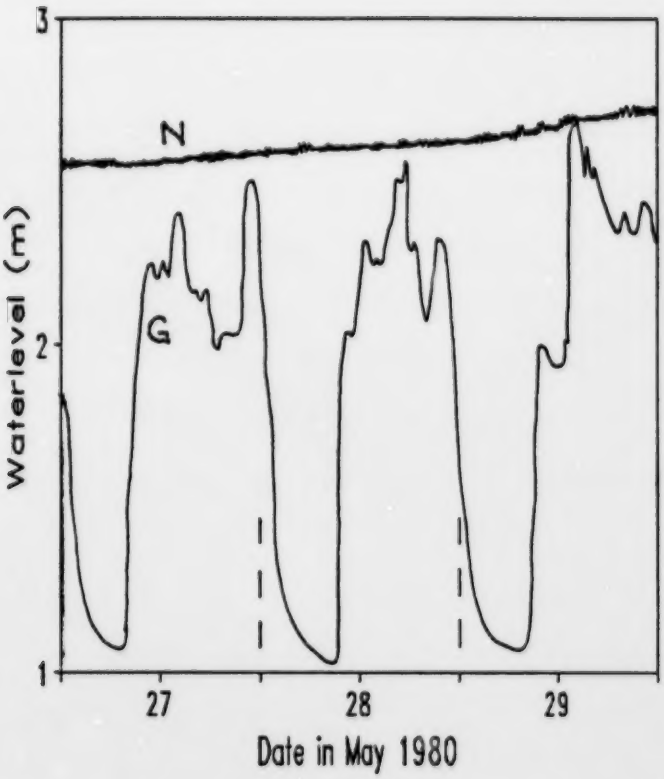


Figure 9. Fluctuations in waterlevels in May 1980 under regulated conditions (curve G) and historically under natural conditions (curve N).

This problem presumably increased after 1968 when the Gardiner dam began operation, as the Squaw Rapids station had low storage capacity and was used for peakload hydro-electric purposes.

Fluctuations have probably also affected food conditions for sturgeon in the "tidal zone" downstream of dams. This is the zone of a river which is periodically exposed by regular, usually daily fluctuations in flows (Fisher and LaVoy 1972). Short-term fluctuations are destructive to many river-dwelling species, and the biomass and diversity of molluscs and many aquatic insects commonly decline (Baxter and Glaude 1980, Fisher and LaVoy 1972). Young lake sturgeon feed preferentially on insects in the South Saskatchewan River in Alberta (Haugen 1969); large sturgeon are opportunistic feeders (Harkness and Dymond 1961).

5. STATUS IN 1990

The long-term effects of reduced reproduction were confirmed in 1990. The late entry of sturgeon into the fishery (about age 19) meant that some changes in the abundance of 1960 and later year-classes were not observable until 1980 and later.

Trends since 1980 show the effects of reduced reproduction and lower numbers of sturgeon growing from small

to medium and large sizes (Fig. 10). About 1979 or 1982, the proportion of sturgeon over 17 pounds (dressed weight) began to increase. This implies a lower absolute abundance of 12 to 17-pound fish as a result of the impacts on reproduction.

Reduced numbers of 12 to 20-pound sturgeon caused a similar proportional increase in sturgeon over 20 pounds about the same time.

By 1986, the lack of reproduction had affected the 12 to 23-pound segment, so that sturgeon over 23 pounds increased in relative abundance. The change has not yet affected the entire 12 to 29-pound segment and sturgeon over 29 pounds have not increased proportionally.

This interpretation is consistent with the loss of mature females and loss of spawning habitat about 1960. Fluctuations in these trends of size may be due to variations in commercial fishing and sturgeon behaviour, reporting methods, or size-at-age of individual sturgeon. In the 1950's the fishery ran from June to August, in the 1970's from June to early July, and since 1984 in June and August again. Separate movements of different size-classes of sturgeon may create irregularity in their catchability. Record-keeping by commercial buyers has varied, some weight classes needed to be interpolated, and variations in age of $\pm$ 3 to 5 years for sturgeon of the same weight were observed.

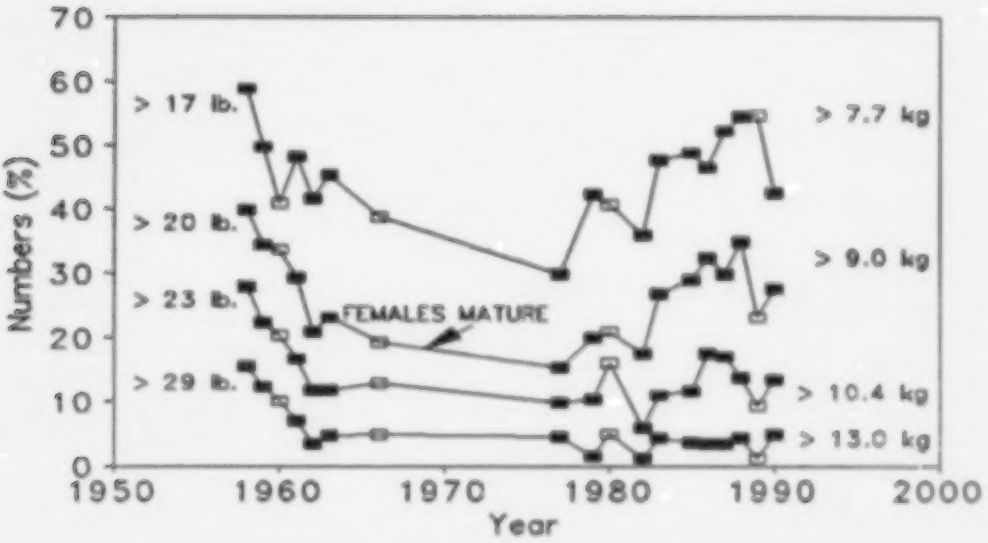


Figure 10. Proportions of larger sturgeon in commercial harvests, 1958 to 1990.

There has been a notable change in age composition, particularly a low number of sturgeon under age 24 in 1990 compared to earlier years (Fig. 11). The peak of recruitment has shifted to age 24 from 19 years since 1975-1980.

The age composition of sturgeon in 1990 is believed to reflect several factors. If the abundance of sturgeon born in 1958 and later was affected, peak recruitment would occur at age 32 in 1990. If the impacts began in 1963, peak recruitment would occur at age 28, and the number of sturgeon aged 19-27 would be low in 1990. In fact, there is a noticeable peak about age 32 in the 1990 ages, a peak which was not obvious in 1975-1980 harvests, and numbers of fish aged 19-23 are low. This implies that the impact occurred as early as 1958 and increased about 1967.

At the same time, the behaviour of mature sturgeon (about age 24 for females) may inflate their representation in the 1990 age composition. This might feasibly be due to higher migratory activity by mature females and greater catchability of spawners in the traditional fishing areas. Other studies have noted similar peaks at the ages of male and female spawning (Ricker 1975 p.65, Priegel and Wirth 1975). A similar peak at age 24 occurred in the 1975-1980 harvests but was less noticeable because ages 19-23 were well represented.

The alternative explanation of low numbers of sturgeon under age 24 is that further degradation of habitat since 1967 depressed ages 23 and younger even more so than

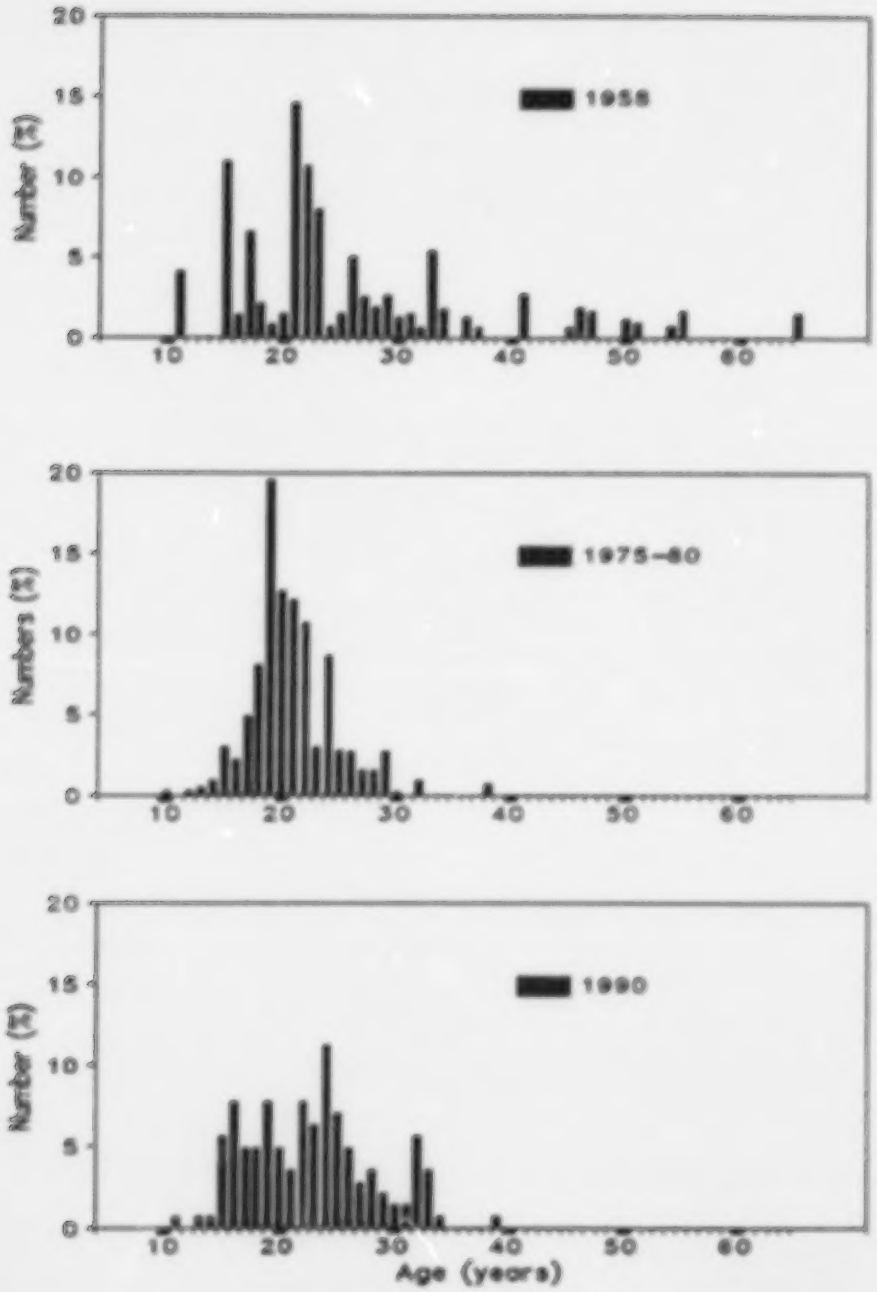
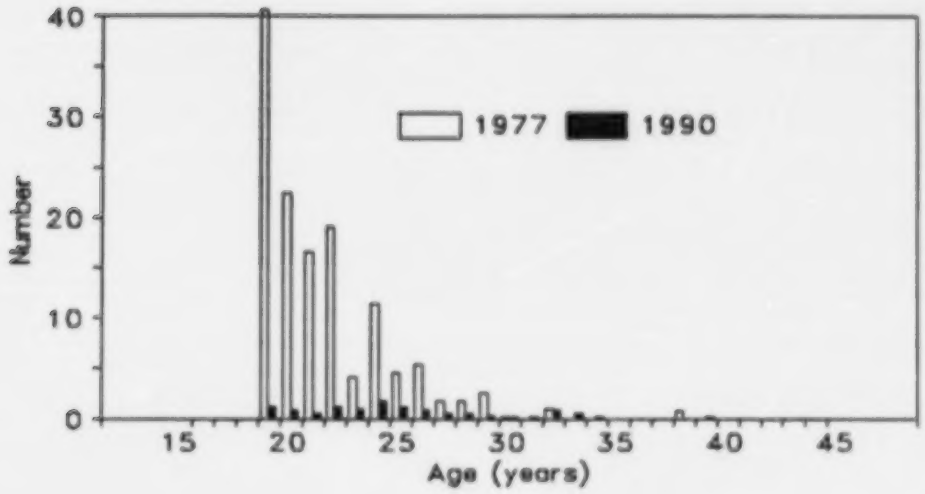


Figure 11. Age compositions of sturgeon in commercial harvests in 1958, 1975-80, and 1990.

ages 24-31. This cannot be demonstrated without an evaluation of year-to-year habitat suitability.

The changes in size and age compositions indicate a lack of recruitment, rather than recovery of the population, for several reasons. Firstly, the timing: the effects of loss of spawners and habitat on recruitment was noticeable about 1978-1982, while recovery through growth of medium-sized sturgeon should have been noted sooner. Secondly, the trends in larger-sized sturgeon are consistent with the movement of reduced year-classes through the medium-size segment. Thirdly, there has been no significant increase in maximum size or age and no major decline in mortality since 1975-1980. The mortality rate is 14.7% for ages 24 and older in 1990, which is similar to that of 1975-1980. Finally, there is the direct evidence in 1990 of reduced abundances of 1958 and later year-classes.

According to the age composition and year-class abundances of sturgeon caught commercially in 1990, only 8 to 15% of the former number of sturgeon are being reproduced since 1958 (Fig. 12). This estimate assumes that the initial abundance and later survival of the 1939-1945 and 1951-1958 year-classes of sturgeon were similar. That is, the number of sturgeon aged 32 and older should be equal in 1977, 1979, and 1990 catches. On this basis, the relative numbers of younger sturgeon indicate the relative success of reproduction and recruitment for ages 19 to 31.



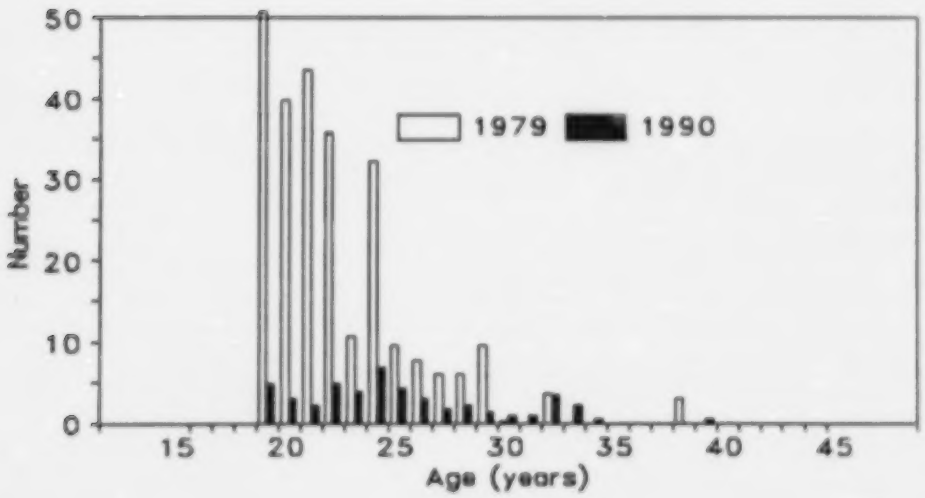


Figure 12. Numbers of sturgeon in 1977 and 1979 compared to 1990, indicating the loss of reproduction and recruitment of sturgeon under age-32 (see text).

A variation of this estimate indicates slightly higher rates of 14 to 27% of former reproductive levels, assuming equal abundance of ages 28 and older. This may be less reliable since the year-classes of 1959-1962 arose during the presumed period of impact.

There is also evidence to suggest even lower reproductive success since 1958. Firstly, commercial fishing continued above sustainable levels of the post-1958 situation and the abundance of older sturgeon most likely declined rather than remained steady. If the abundance of ages 32 and older fell by half from 1977 to 1990, the estimate is that only 4 to 8% of required reproduction occurred under the conditions of 1959 to 1971.

Secondly, the age composition of a sub-sample of fish caught in 1990 indicated a lower success of 6 to 13%. This sub-sample comprised only data representing at least 70% of the sturgeon delivered by an individual fisherman on any date. This reduced any potential bias towards older or younger fish, compared to the entire sample.

6. MANAGEMENT OPTIONS

Reviews by conservation agencies have assessed lake sturgeon as endangered (CITES per Houston 1987), threatened by habitat degradation (AFS in Deacon et al. 1979), in jeopardy if

management and habitat protection are not undertaken (COSEWIC April 1986 in Houston 1987), or under review (COSEWIC August 1989 in Campbell 1990).

Management options should recognize the fact that the recovery of this population requires action on several issues. The following factors predominate:

Habitat impacts have affected reproduction seriously since 1960 due to loss of spawning areas, loss of mature sturgeon, and reduced waterflows.

Commercial and sport harvests were formerly sustainable, but will result in the loss of the remaining mature sturgeon under the present quotas and minimum-size restrictions.

6.1 STATUS QUO:

Leave habitat conditions unchanged and commercial and sport fishing unchanged.

This will lead to a population collapse to a new, much lower abundance or local extinction in the lower Saskatchewan River (within about 10 years).

6.2 INFORMATION:

Advise fishermen (especially at Cumberland House) and relevant agencies (particularly SPC and Manitoba) of the status of the population, provide available information for

their assessment and study if requested, and advise on any biological issues.

Commercial fishermen will probably point to habitat impacts about 1960 and ongoing effects of reduced waterflows as major issues. Progress on other issues will require that the reasons for changes about 1960 be open for discussion. Fishermen were advised in 1984 that harvests were not sustainable, but the lawsuit against SPC prevented any useful discussion of causes and solutions.

The question of whether or not compensation to Cumberland House residents included the sturgeon fishery may become important. Advice provided by Fisheries Branch to the Department of Justice substantiated some aspects of their claims regarding sturgeon (R.G. Wallace, December 1983, Fisheries Branch files), but this may not have been recognized in the settlement.

6.3 HABITAT AND FISHING:

Restore major spawning areas or create or enhance new spawning sites, and stabilize waterlevels during spawning, AND reduce fishing impacts generally and fishing of the mature segment of the population in particular.

These actions together should stabilize and restore population abundance to former levels (in about 20 years).

The former spawning rapids and the power-station tailrace are important candidate areas for restoration.

Spawning sites have been created or enhanced using rip-rap (Folz and Meyers 1985) and other techniques (R. Fortin, University of Quebec (Montreal), pers. comm.).

Reduced harvests should improve the survival of immature sturgeon to mature size, and allow more of the existing spawners to utilize restored spawning habitat for more years.

Protection of mature sturgeon specifically is needed. The present regulation of minimum gillnet mesh and the agreement on minimum marketable size, actually direct effort and mortality onto the reproductive segment.

6.4 HABITAT ONLY:

Sturgeon require clean rocks or rubble, reasonable water depth (minimum 1-3 m), and stable flows during spawning and incubation in late May and June. A minimum instantaneous water flow is required to allow spawning and protect eggs and fry. The minimum, daily, average release of 150 m^3/second required since 1980 will not suffice as overnight drying occurs. The critical period for minimum flows could be confirmed by observation and monitored using daily water temperatures at the SPC Squaw Rapids power station. Spawning temperatures of 11-16°C occurred from May 15 to June 5 under natural flow conditions (Canada 1970).

Modification of the Tobin dam spillway or tailrace area and sufficient release of water may replace much of the

lost habitat. One concern may be whether electrical fields at the power station would inhibit sturgeon activity, as reported for high-voltage lines (N. Auer, Michigan Technical University, pers. comm.).

All potential spawning sites and migration routes on the Saskatchewan, Torch, Mossy, and other rivers should be protected from impacts (e.g. weirs and low waterflows). Specifically, sturgeon passage should be required in any weir or bridge below Bigstone Rapids (Canada 1977, Willard et al. 1978). Information on design requirements should be available (Pavlov 1989; Webb 1986; M. Endris, Wisconsin Dep. Natural Resources, pers. comm.; N. Auer pers. comm.; C. Katopodis, Dep. Fisheries and Oceans, pers. comm.).

Habitat mitigation or restoration requires restrictions on fishing. Otherwise, the existing mature sturgeon will probably be depleted 15 years before enhanced year-classes mature.

6.5 FISHING ONLY:

Reduced harvests by all users will increase the survival of immature sturgeon to reproductive ages, and the numbers of spawnings for existing mature sturgeon.

Reductions in harvests of 25 to 50% (for about 15 years) will probably be required to be effective, and complete cessation of fishing would improve the likelihood of recovery. A commercial quota cannot reliably be set for this non-

equilibrium situation and must be updated according to monitoring of size, age, and abundance trends.

Sport fishing requires reductions in total harvests and closure of spawning sites to demonstrate that conservation, rather than allocation, is the intent of restrictions. Present regulations allow one sturgeon daily and two in possession, but do not address these issues. Several provinces and states have more specific quotas: Alberta allows only 1 sturgeon/day and 2/year using special licences, and Wisconsin has restored an overexploited population using a lottery-draw for licences.

Use of a maximum retainable size of sturgeon (about 20-30 kg or 44-66 pounds round weight) is advisable to protect spawners to some degree. Maximum size limits have been recommended or imposed on lake sturgeon and similar species (Dumont et al. 1987, Scarnecchia et al. 1989). The present minimum size of 8.2 kg round weight does not protect spawners, and cannot be increased to be effective without eliminating the fishery.

Two issues for maximum-size restrictions will be: (1) Co-operation from users and enforcement are both needed to protect large sturgeon worth $ 150 each to commercial fishermen and "trophy" status to sport fishermen. Otherwise, sturgeon are hardy and should survive capture and release well. (2) A review of the biological benefits of this approach may be requested by users, but relatively few studies have been reported.

Restrictions on fishing will not return this population to its former status without habitat restoration. Furthermore, the original cause of the present situation was only indirectly related to fishing, if at all.

6.6 ENHANCEMENT:

Further study of habitat enhancement will be needed, especially regarding critical habitat areas and other site-specific proposals. Additional feasibility studies by outside consultants may be necessary.

Restocking lake sturgeon from a local or other hatchery may deserve consideration. Many fish species have been successfully introduced or supplemented through judicious hatchery use. Techniques for rearing other sturgeon species are known and earlier problems with lake sturgeon have been overcome recently (Conte et al. 1988, Anderson 1984, Czeskleba et al. 1985).

A hatchery for lake sturgeon would show that efforts are being made, particularly if it were successful. One alternative is to build a local hatchery to create high visibility and some employment. Another is to request use of Manitoba's hatchery at Grand Rapids on the Saskatchewan River.

Major concerns regarding restocking include the lack of identifiable egg sources in Saskatchewan, the importance of suitable genetic strains (Thuemler 1988), the cost and uncertainty of rearing a new species, and the long period

before any recruitment or spawning. Other agencies have asked if eggs are available for commerce or recovery programs, but there are no known reliable sources in Saskatchewan (G.E. Couldwell, Sept. 1983, Fisheries Branch files; B.L. Smith, February 1990, Fisheries Branch files).

6.7 INTERPROVINCIAL:

Manitoba biologists suggest that this population migrates between Saskatchewan and Manitoba. Their commercial fishery was closed from 1960 until 1974 in the Saskatchewan River, primarily due to provincial concerns for all sturgeon populations (Sunde 1961). In the renewed fishery, harvests reached the quota for a few years, before declining markedly (B. Wright, Manitoba Dep. Natural Resources, pers. comm.). Available data from Manitoba has been examined, but is sparse due to the short period of its fishery.

Colleagues in Manitoba have assisted this study whenever possible and have requested any updates on lake sturgeon status. They have shown an interest in conservation and may be able to assist with restoration.

6.8 FUNDING:

Funding from suitable federal or provincial programs may be available (e.g. RENEW - Recovery of Nationally Endangered Wildlife, and ESRF - Endangered Species Recovery Fund) to restore habitat, to protect reproduction, and to

monitor progress.

Manitoba should be asked formally to co-operate in the management of commercial, sport, and food fisheries, in any biological monitoring, and in any restocking or other enhancement program. Manitoba has declared the lake sturgeon to be a Heritage Species, which increases its profile and suggests that co-operative initiatives may be eligible for funding.

In Saskatchewan, University of Manitoba and visiting scientists are researching parasites and diseases in lake sturgeon in the lower Saskatchewan River. Increasing its profile within Saskatchewan may encourage study of habitat restoration and mitigation, population movements, and other issues by university and related agencies.

7. RECOMMENDATIONS

1. This proposed Recovery Plan should be approved by the Department and implemented fully.
2. The Management Options outlined above should be discussed with users and other agencies, and should be addressed in the implementation of the plan.
3. Action on the components of Information, Habitat, Fishing, and Funding are first priority, and should begin in 1991. Other components should be undertaken as soon as practicable in 1991 or 1992.

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